

**IN THE CLAIMS:**

- 1 1. (Original): A policer based on Random Early Detection (RED), comprising:  
2 a filter that determines a filtered virtual time debt; and  
3 a control law circuit that receives the filtered virtual time debt from the filter and  
4 determines whether a packet should be dropped.
- 1 2. (Original): The RED policer of claim 1, wherein a virtual time debt uses a time T in  
2 which a packet is expected to arrive and is computed using a predetermined output  
3 transmission rate.
- 1 3. (Original): The RED policer of claim 2, wherein predetermined output transmission  
2 rate is given by a traffic contract.
- 1 4. (Previously Presented): The RED policer of claim 1, wherein the filter is based on an  
2 exponential weighted moving average (EWMA) virtual time delay using the expression,  
3 
$$EWMA_k = (1-g)EWMA_{k-1} + g(VTD)_k,$$
  
4 where k indicates the presently received packet, and k-1 indicates the last packet  
5 received, the virtual time debt (VTD) is computed by the expression:  $VTD = T(\text{packet}$   
6  $\text{expected to arrive}) - T(\text{packet actually arrives}),$  and g is the gain of the filter.
- 1 5. (Original): The RED policer of claim 1, further comprises a sampler that samples a  
2 virtual time debt at a sampling interval, and transmits the sampled virtual time debt to the  
3 filter.

1 6. (Original): The RED policer of claim 1, further comprises:

2 a random generator that generates a number based on the control law circuit's de-  
3 termination as to whether a packet should be dropped; and

4 a counter that is set with the number generated by the random generator, wherein  
5 the counter counts packets passing through the RED policer up to the set number, and  
6 wherein the RED policer drops a packet when the counter has counted out the set num-  
7 ber.

1 7. (Original): The RED policer of claim 6, further comprises:

2 the control law circuit that determines a probability of a packet being dropped  
3 based on the filtered time debt exceeding a predetermined minimum threshold, and speci-  
4 fies a range of numbers based on the probability; and

5 the random generator that randomly generates a number in the range specified by  
6 the control law circuit.

1 8. (Original): A policer based on Random Early Detection (RED), comprising:

2 means for determining a moving average of a virtual time debt; and

3 means for determining whether a packet should be dropped based on a value of  
4 the moving average of the virtual time debt.

1 9. (Original): The RED policer of claim 8, further comprises means for sampling a vir-  
2 tual time debt at a sampling interval, and transmitting the result to the moving average  
3 determining means.

1 10. (Original): The RED policer of claim 8, further comprises:

2 means for generating a random number based on the result of the packet dropping  
3 means; and

4 means for counting a number of packets passing through the RED policer up to  
5 the random number generated by the random number generating means, wherein the  
6 RED policer drops a packet when the counting means has counted out the generated ran-  
7 dom number.

1 11. (Original): A network device comprising:

2 a plurality of Random Early Detection (RED) policers, wherein each RED policer  
3 includes,

4 a filter that determines a filtered virtual time debt; and

5 a control law circuit that receives the filtered virtual time debt from the fil-  
6 ter and determines whether a packet should be dropped; and

7 a packet classifier that determines which packet should go to which RED policer.

1 12. (Previously Presented): A method of policing packets in a network device, the  
2 method comprising the steps of:

3 determining a filtered virtual time debt of a traffic;

4 comparing the filtered virtual time debt with a predetermined minimum threshold;  
5 and if the filtered virtual time debt exceeds the minimum threshold, then

6 generating a random number that is used to determine which packet should be  
7 dropped.

1 13. (Original): The method of claim 12, wherein generating a random number further  
2 comprises the steps of:

3           generating the random number in a range based on a level by which the filtered  
4   virtual time debt exceeds the minimum threshold;  
5           setting a counter with the random number; and  
6           dropping a packet when the counter has counted out the random number.

1   14. (Previously Presented): A computer readable medium having instructions contained  
2   therein, which when executed by a computer performs a method comprising the steps of:

3           determining a filtered virtual time debt of a traffic;  
4           comparing the filtered virtual time debt with a predetermined minimum threshold;  
5   and if the filtered virtual time debt exceeds the minimum threshold, then  
6           generating a random number that is used to determine which packet should be  
7   dropped.

1   15. (Original): The medium of claim 14, wherein generating a random number further  
2   comprises the steps of:

3           generating the random number in a range based on a level the filtered virtual time  
4   debt exceeds the minimum threshold;  
5           setting a counter with the random number; and  
6           dropping a packet when the counter has counted out the random number.

1   16. (Previously Presented): Electromagnetic signals propagating over a computer net-  
2   work, said electromagnetic signals carrying instructions for execution on a processor for  
3   the practice of the method comprising the steps of:

4           determining a filtered virtual time debt of a traffic;

5           comparing the filtered virtual time debt with a predetermined minimum threshold;  
6   and if the filtered virtual time debt exceeds the minimum threshold, then  
7           generating a random number that is used to determine which packet should be  
8   dropped.

1   17. (Previously Presented): A method of policing packets in a network device, the  
2   method comprising the steps of:

3           determining a virtual time debt of packets flowing through the network device;  
4   and

5           determining whether a packet should be dropped based on the virtual time debt of  
6   the packets.

1   18. (Previously Presented): The method as in claim 17, further comprising: determining  
2   that a packet should be dropped when a virtual time debt threshold has been reached.

1   19. (Previously Presented): The method as in claim 17, further comprising: determining  
2   a moving average of the virtual time debt.

1   20. (Previously Presented): The method as in claim 17, further comprising: calculating  
2   the virtual time debt as the difference between a time a packet is expected to arrive and a  
3   time the packet actually arrives.

1   21. (Previously Presented): The method as in claim 20, further comprising: calculating  
2   the time a packet is expected to arrive according to a traffic contract.

1 22. (Previously Presented): The method as in claim 17, further comprising: sampling the  
2 virtual time debt at a sampling interval.

1 23. (Previously Presented): The method as in claim 17, further comprising:  
2 generating a random number;  
3 counting a number of packets passing through the network device up to the ran-  
4 dom number; and  
5 dropping a packet when the counted number reaches the random number.

1 24. (Currently Amended): A method of policing packets in a network device, the  
2 method comprising the steps of:  
3 determining a virtual time debt of packets flowing through the network device,  
4 the virtual time debt computed as a positive delay from an expected packet arrival time  
5 established by a traffic contract to an actual packet arrival time;  
6 determining that packets should be dropped when the virtual time debt of the  
7 packets exceeds a predetermined value; and if so  
8 choosing a packet to be dropped, the chosen packet in response to a random num-  
9 ber; and  
10 dropping the chosen packet.

1 25. (Previously Presented): The method as in claim 24, further comprising:  
2 generating the random number  
3 counting a number of packets passing through the network device up to the ran-  
4 dom number; and

5           dropping a packet when the counted number reaches the random number.

1   26. (Currently Amended): A policer, comprising:

2           means for determining a virtual time debt of packets flowing through the network  
3   device, the virtual time debt computed as a positive delay from an expected packet arrival  
4   time established by a traffic contract to an actual packet arrival time;

5           means for determining that packets should be dropped when the virtual time debt  
6   of the packets exceeds a predetermined value; and if so

7           means for choosing a packet to be dropped, the chosen packet in response to a  
8   random number; and

9           means for dropping the chosen packet.

1   27. (Previously Presented): A computer readable media, the computer readable media  
2   containing instructions for execution in a processor for the practice of the method com-  
3   prising the steps of:

4           determining a virtual time debt of packets flowing through the network device;  
5   and

6           determining whether a packet should be dropped based on the virtual time debt of  
7   the packets.

1   28. (Previously Presented): Electromagnetic signals propagating on a computer network,  
2   the electromagnetic signals carrying instructions for execution in a processor for the prac-  
3   tice of the method comprising the steps of:

4           determining a virtual time debt of packets flowing through the network device;  
5   and

6           determining whether a packet should be dropped based on the virtual time debt of  
7   the packets.

1   29. (Currently Amended): A method of policing packets in a network device, the  
2   method comprising the steps of:

3           determining a virtual time debt of packets flowing through the network device,  
4   the virtual time debt computed as a positive delay from an expected packet arrival time to  
5   an actual packet arrival time; and

6           determining whether a packet should be dropped based on the virtual time debt of  
7   the packets.

1   30. (Previously Presented): The method as in claim 29, in the event a packet should be  
2   dropped, further comprising:

3           generating a random number;

4           counting a number of packets passing through the network device up to the ran-  
5   dom number; and

6           dropping a packet when the counted number reaches the random number.



1 Please Add New Claims 31 *et al.*

1 31. (New): A method of policing packets in a network device, comprising:

2 determining an actual arrival time of a packet;

3 determining a theoretical arrival time of the packet;

4 calculating a virtual time debt in response to the actual arrival time and the theo-  
5 retical arrival time;

6 comparing the virtual time debt with a predetermined value;

7 deciding if the virtual time debt exceeds the predetermined value; and

8 generating, in response to the virtual time debt exceeding the predetermined  
9 value, a random number that is used to determine which packet should be dropped.

1 32. (New): The method of claim 31, further comprising:

2 using a filter to determine a filtered virtual time debt of a traffic.

1 33. (New): The method of claim 31, further comprising:

2 using a time T in which the packet is expected to arrive; and

3 computing a predetermined output transmission rate.

1 34. (New): The method of claim 33, further comprising:

2 setting the predetermined output transmission rate by a traffic contract.

1 35. (New): The method of claim 32, further comprising:

2 sampling the virtual time debt at a sampling interval; and

3 transmitting the sampled virtual time debt to the filter.

1 36. (New): The method of claim 31, further comprising:

2 using a counter that is set with the number generated by the random number gen-  
3 erator;

4 counting packets passing through a RED policer up to the set number;

5 dropping the packet when the counter has counted out the set number.

1 37. (New): The method of claim 31, further comprising:

2 determining a moving average of the virtual time debt; and

3 determining whether a packet should be dropped based on a value of the moving  
4 average of the virtual time debt.

1 38. (New): A policer based on Random Early Detection (RED), comprising:

2 an operating system determines an actual arrival time of a packet and a theoretical  
3 arrival time of the packet;

4 a control law circuit that calculates a virtual time debt in response to the actual ar-  
5 rival time and the theoretical arrival time, compares the virtual time debt with a prede-  
6 termined value, and decides if the virtual time debt exceeds the predetermined value; and

7 a random number generator that generates, in response to the virtual time debt ex-  
8 ceeding the predetermined value, a random number that is used to determine which  
9 packet should be dropped.

1 39. (New): The policer of claim 38, further comprising:

2 a filter that determines a filtered virtual time debt of a traffic.

1 40. (New): The policer of claim 38, further comprising:

2 the virtual time debt uses time T in which the packet is expected to arrive, and is  
3 computed using a predetermined output transmission rate.

1 41. (New): The policer of claim 40, further comprising:

2 the predetermined output transmission rate is given by a traffic contract.

1 42. (New): The policer of claim 39, further comprising:

2 a sampler that samples the virtual time debt at a sampling interval and transmits  
3 the sampled virtual time debt to the filter.

1 43. (New): The policer of claim 38, further comprising:

2 a counter that is set with the number generated by the random number generator,  
3 and counts packets passing through the RED policer up to the set number; and

4 the RED policer drops the packet when the counter has counted out the set num-  
5 ber.

1 44. (New): The policer of claim 38, further comprising:  
2 a filter that determines a moving average of the virtual time debt; and  
3 a control law circuit that determines whether a packet should be dropped based on  
4 a value of the moving average of the virtual time debt.

1 45. (New): An apparatus for policing packets in a network device, comprising:  
2 means for determining an actual arrival time of a packet;  
3 means for determining a theoretical arrival time of the packet;  
4 means for calculating a virtual time debt in response to the actual arrival time and  
5 the theoretical arrival time;  
6 means for comparing the virtual time debt with a predetermined value;  
7 means for deciding if the virtual time debt exceeds the predetermined value; and  
8 means for generating, in response to the virtual time debt exceeding the predeter-  
9 mined value, a random number that is used to determine which packet should be dropped.

1 46. (New): The apparatus of claim 45, further comprising:  
2 means for using a filter to determine a filtered virtual time debt of a traffic.

1 47. (New): The apparatus of claim 45, further comprising:  
2 means for using a time T in which the packet is expected to arrive; and  
3 means for computing a predetermined output transmission rate.

1 48. (New): The apparatus of claim 47, further comprising:

2 means for setting the predetermined output transmission rate by a traffic contract.

1 49. (New): The apparatus of claim 46, further comprising:

2 means for sampling the virtual time debt at a sampling interval; and

3 means for transmitting the sampled virtual time debt to the filter.

1 50. (New): The apparatus of claim 45, further comprising:

2 means for using a counter that is set with the number generated by the random  
3 number generator;

4 means for counting packets passing through a RED policer up to the set number;

5 means for dropping the packet when the counter has counted out the set number.

1 51. (New): The apparatus of claim 45, further comprising:

2 means for determining a moving average of the virtual time debt; and

3 means for determining whether a packet should be dropped based on a value of  
4 the moving average of the virtual time debt.

1 52. (New): A computer readable medium having instructions contained therein, which  
2 when executed by a computer performs a method comprising the steps of:

1 determining an actual arrival time of a packet;

2 determining a theoretical arrival time of the packet;

3 calculating a virtual time debt in response to the actual arrival time and the theo-  
4 retical arrival time;

5 comparing the virtual time debt with a predetermined value;  
6 deciding if the virtual time debt exceeds the predetermined value; and  
7 generating, in response to the virtual time debt exceeding the predetermined  
8 value, a random number that is used to determine which packet should be dropped.

1 53. (New): Electromagnetic signals propagating on a computer network, the electro-  
2 magnetic signals carrying instructions for execution in a processor for the practice of the  
3 method comprising the steps of:  
4 determining an actual arrival time of a packet;  
5 determining a theoretical arrival time of the packet;  
6 calculating a virtual time debt in response to the actual arrival time and the theo-  
7 retical arrival time;  
8 comparing the virtual time debt with a predetermined value;  
9 deciding if the virtual time debt exceeds the predetermined value; and  
10 generating, in response to the virtual time debt exceeding the predetermined  
11 value, a random number that is used to determine which packet should be dropped.